

**CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY -
MARINE ENGINEER OFFICER**

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 78 as amended CHIEF ENGINEER REG. III/2 (UNLIMITED)

041-33 - ELECTROTECHNOLOGY

THURSDAY, 20 OCTOBER 2016

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q3

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.
2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook
Graph paper

ELECTROTECHNOLOGY

Attempt SIX questions only.

All questions carry equal marks.

Marks for each part question are shown in brackets.

1. For the network shown in Fig Q1 calculate EACH of the following:
- (a) the current drawn from each battery; (8)
 - (b) the potential difference across the $40\ \Omega$ resistor and the $50\ \Omega$ resistor; (4)
 - (c) the power dissipated in the $60\ \Omega$ resistor. (4)

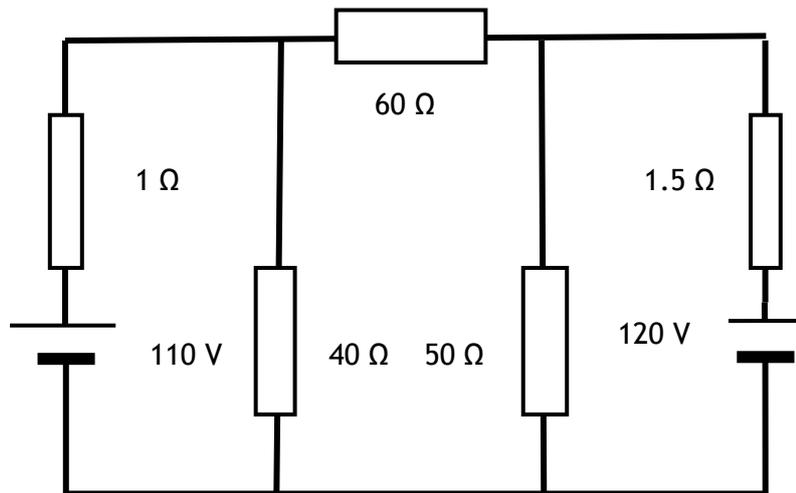


Fig Q1

2. The V/I characteristics of a non-linear resistor are given in Table Q2 below.

V (volts)	40	60	80	100	120	140
I (mA)	0.65	1.05	1.55	2.20	3.20	4.70

Table Q2

The non-linear resistor is connected in series with a paralleled pair of resistors of 40 K Ω and 60 K Ω and the overall circuit is supplied at 140 V. d.c.

Determine graphically or otherwise:

- (a) the current in the non-linear resistor; (8)
 - (b) the effective resistance of the non-linear resistor; (4)
 - (c) The current in the 40 K Ω resistor. (4)
3. A power silicon transistor with the characteristics given in Worksheet Q3 is operated from a 16 V d.c. supply. The operating ('quiescent') point is $I_b = 40$ mA and $I_c = 3.8$ A and the maximum collector current is 6 A.
- (a) Draw the load line on the characteristics. (4)
 - (b) Determine EACH of the following:
 - (i) the value of the collector load resistance; (4)
 - (ii) the peak-to-peak variation in collector current if a signal of ± 40 mA is applied to the base; (2)
 - (iii) the corresponding variation in collector voltage; (2)
 - (iv) the power dissipated in the transistor due to this signal. (4)

4. An a.c. series circuit consists of four elements as shown in Fig Q4. The power dissipated in the $50\ \Omega$ resistor is $200\ \text{W}$ and the volt drops across the various parts of the circuit are as shown.

Calculate EACH of the following:

- (a) the values of C and L; (8)
 (b) the overall power factor of the circuit; (4)
 (c) the kVAr for the inductance. (4)

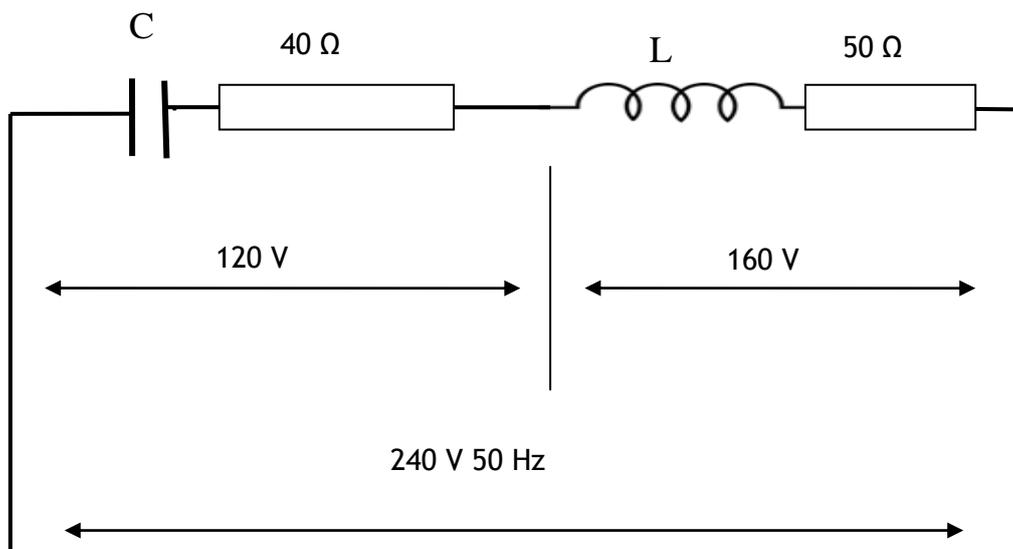


Fig Q4

5. A balanced three phase load is star connected and has a capacitor of $100\ \mu\text{F}$ in series with a resistor of $30\ \Omega$ in each phase. It is connected to a three phase supply of $440\ \text{V}\ 50\ \text{Hz}$.

Calculate EACH of the following:

- (a) the line current; (6)
 (b) the power factor of the load; (4)
 (c) the value of each of three identical delta connected resistors which, when connected to the same supply, will raise the overall power factor to 0.9. (6)

6. A 440 V/110 V single phase transformer takes a no load current of 5 A at power factor 0.25 lag. On load the transformer supplies 7.5 kVA at power factor 0.8 lag.

Calculate EACH of the following, for the on load condition:

- (a) the transformer secondary current; (2)
 - (b) the transformer primary current; (8)
 - (c) the primary power factor; (3)
 - (d) the efficiency of the transformer at this load. (3)
7. (a) List the various losses which occur in a squirrel cage motor on load. (4)
- (b) State, with reasons, which of these losses are:
- (i) independent of load current and speed; (4)
 - (ii) dependent on load current; (4)
 - (iii) dependent on speed. (4)
8. (a) Sketch the circuit arrangement for a full wave three phase rectifier indicating on your sketch the current directions for both half cycles of one phase. (8)
- (b) Sketch the output waveform for the circuit in Q8(a). (3)
- (c) Add a smoothing capacitor to the rectifier circuit and explain why less smoothing capacitance is needed for the three phase rectifier set compared to a single phase rectifier. (5)
9. (a) Explain what is meant by the term *single phasing*. (6)
- (b) State the probable effect of single phasing of a three phase induction motor operating on load. (4)
- (c) State ONE method by which a motor can be protected against the effects of single phasing. (6)